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DIGITAL SENSOR SIMULATION AT THE DEFENSE MAPPING AGENCY AEROSPA--ETC(U)  
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LEVEL II

DIGITAL SENSOR SIMULATION AT THE  
DEFENSE MAPPING AGENCY AEROSPACE CENTER

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ABSTRACT

The primary objective of the digital sensor simulation investigations being conducted at the Defense Mapping Agency Aerospace Center (DMAAC) is to establish an editing and analysis capability for digital culture and terrain data bases. These data bases are being produced by DMAAC to support advanced aircraft simulators by providing an improved low level radar training capability offered by digitally generated radar landmass images. As a result of the technology developed for aircraft simulator support, sensor guidance reference scenes, visual, and microwave scenes are also being digitally generated. Currently, intensive studies are underway to generate synthetic input data bases with apparent resolutions finer than in the original data bases, using supportive data base information. Highly realistic sensor simulations have been generated, and the continuing emphasis is on modeling new sensors as well as improving resolution without increasing data base production costs.

INTRODUCTION

The primary objective of the digital sensor simulation investigations being conducted at the Defense Mapping Agency Aerospace Center (DMAAC) is to establish an editing and analysis capability for the digital culture and terrain data bases. These data bases are being produced by DMAAC to support advanced aircraft simulators by providing an improved low level radar training capability offered by the digitally generated radar landmass images. As a result of the technology developed for the aircraft simulator support, sensor guidance reference scenes are also being generated. In addition to radar scenes, visual and microwave scenes are being digitally generated. Earlier papers (Faintich, 1974, 1976a, 1976b) have detailed initial capabilities in scene generation. Currently, intensive studies are underway to generate synthetic input data bases with apparent resolutions finer than in the original data bases, using supportive data base information. Highly realistic sensor simulations have been generated, and the continuing emphasis is on both modeling new sensors as well as improving resolution without increasing data base production costs.

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## SIMULATION SCENARIO

The scenario for digital radar simulation is to first transform the off-line digital terrain and culture data bases into an on-line terrain and radar reflectance potential data base over a desired gaming area. The on-line data base may be displayed for analysis as a computer generated synthetic image prior to sensor simulations. (See Figure 1.) With radar control settings, weather parameters, and radar location as input, the software first generates an optical perspective geometry view of the observable ground area using predicted radar returns for the associated gray levels. This perspective view is then transformed to the desired radar geometry, and appropriate radar effects are added to the simulation. The final output matrix is then buffered to a hardcopy display device. Similar scenarios exist for other types of sensors, with minor changes in the on-line transformation, and sensor module changes to the simulation software.

The current standard production data bases (Level I) correspond to cultural information displayed on a 1:250,000 scale chart and digital terrain data on a 3" grid. Detailed information is available in Reference 4, "Product Specifications for Digital Landmass System (DLMS) Data Base." In general, this level of information has proven to be adequate for long range (Figure 2) and medium range (Figure 3) radar simulation.

## SYNTHETIC FEATURE BREAK-UP

With the development of advanced high resolution radar and visual simulators, higher resolution cultural data bases are required. Production resources limit this higher resolution data to small geographic areas of interest, and worldwide coverage is unattainable without automated feature extraction techniques. Due to the extremely high production cost for very high resolution off-line data bases, efforts have been underway to simulate high resolution on-line data bases from lower resolution off-line input, and then to generate the simulated sensor scenes from the synthetic data base. Current results show a high degree of potential success associated with enormous cost savings and the appearance of greater resolution in the simulations.

The current high resolution data bases (Level II) correspond to cultural information displayed on a 1:50,000 scale chart. The Level I data base aggregates Level II type information into homogeneous areal features with associated predominant descriptors, including percentage tree and roof cover. The synthetic feature break-up technique generates random cultural, tree cover, and background features within the areal feature boundaries, based on the percentages of tree and roof cover. Cultural descriptors are then randomly assigned with a normal distribution about the predominant values of the original areal features. The

*See Table  
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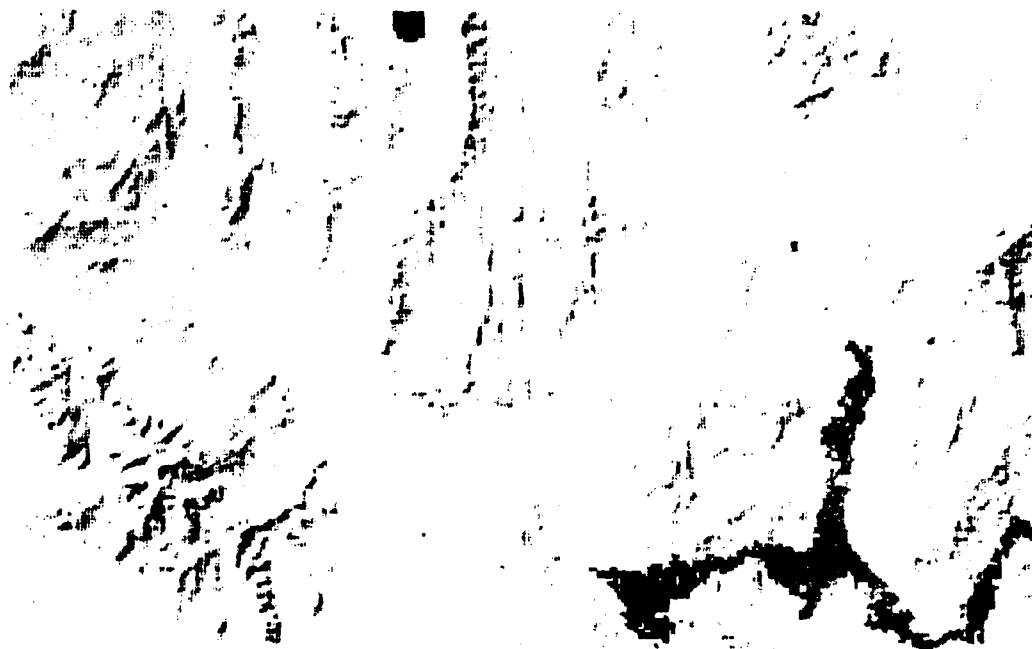


Figure 1. On Line Data Base Display: Las Vegas, Nevada.



Figure 2. Long Range (85 n.m.) Radar Simulation (Left), Actual (right)

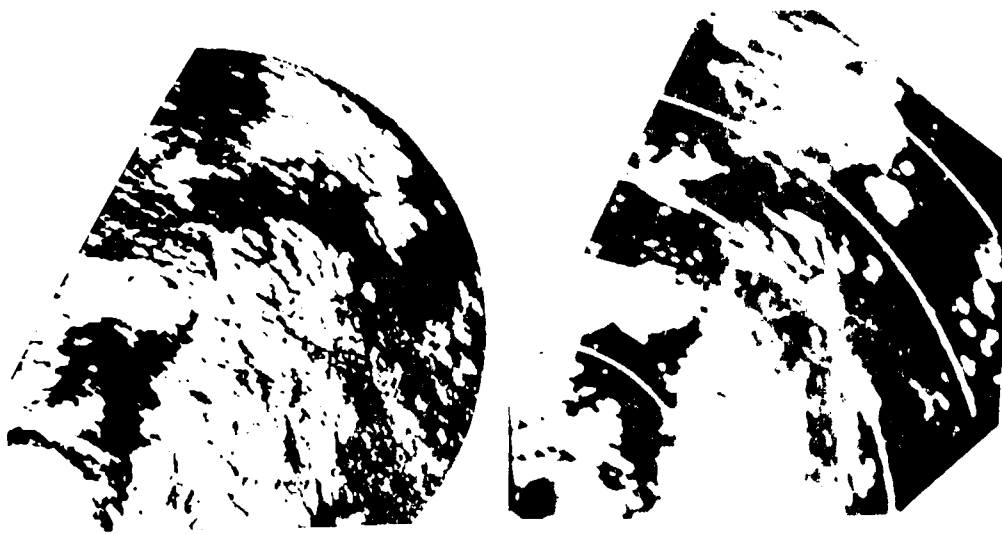


Figure 5. Medium Range Radar Simulation (left); (right)

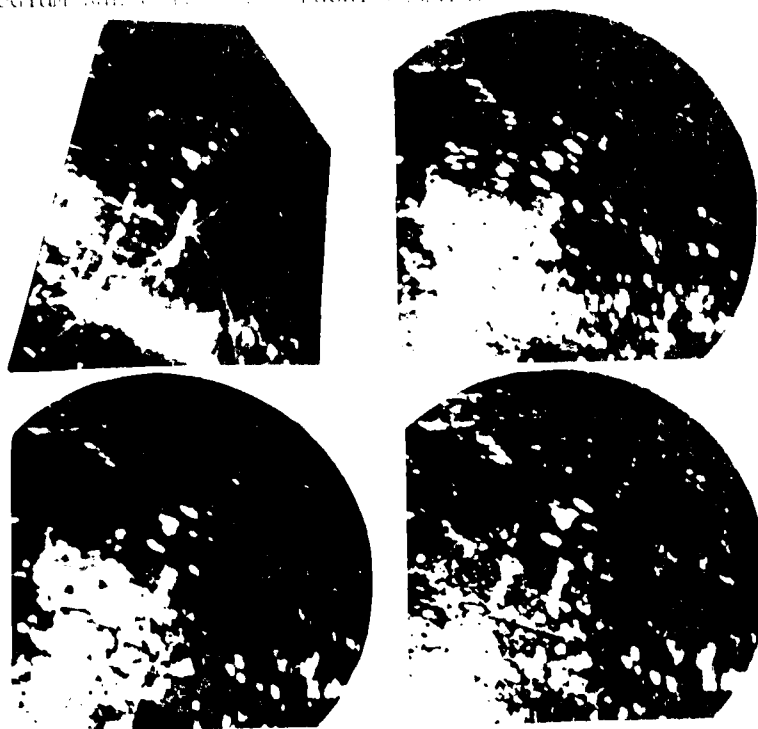


Figure 4. Short Range Radar: Actual (top left); Level II Simulation (top right); Level I Simulation (bottom left); Level I Synthetic Break up Simulation (bottom right)

Level II data also contains aggregate areal features of very high resolution, and the synthetic break-up process may be applied to any level of data. This type of synthetic feature break-up allows for greater realism for Level I simulation as well as the blending of actual Level II data patches within a Level I data base. Figures 4 through 8 are examples of both radar and visual simulations depicting the synthetic break-up technique.

Additional investigations are being undertaken to refine gray level assignments, to add texture to both landscape and man-made cultural features, and to add new types of features to the data base. The development of this sensor simulation capability has played a key role in the refinement of digital data base production specifications.

#### REFERENCES

1. Faintich, M. B.; 1974; "Digital Scene and Image Generation," Naval Weapons Laboratory Technical Report, TR-3147.
2. Faintich, M. B.; 1976a; "Digital Sensor Simulation," Photogrammetric Engineering and Remote Sensing, 42, 11, pp. 1427-1440.
3. Faintich, M. B.; 1976b; "Advances in Digital Sensor Simulation," Proceedings of the American Society of Photogrammetry, Fall Convention, Seattle, Washington, pp. 283-302.
4. Defense Mapping Agency; 1977; "Product Specifications for Digital Landmass System (DLMS) Data Base," St. Louis Air Force Station, Missouri.



Figure 5. Visual Simulations over Spokane, Washington (13,000 ft. AGL);  
Level II (bottom); Level I (middle); Level I with Synthetic Break-up (top)



Figure 6. Level I On-Line Visual Data Base Display (left); With Synthetic Break-up (right)





Figure 7. Level I Visual Simulations (top to bottom): North, South, East, West; All scenes are 1500 ft. AGL, 2.5 n.m. from airfield.



Figure 8. Level I Visual Simulations with Synthetic Break-up (top to bottom): North, South, East, West; All scenes are 1500 ft. AGL, 2.5 n.m. from airfield.